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Quantifying Population Characteristics Within and Outside a 30-Minute Drive-Time to Health Resources and Services Administration-Supported Health Centers

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Abstract: The Health Resources and Services Administration's (HRSA) Health Center Program provides health care to vulnerable persons across the US, regardless of their ability to pay for health care. We examined characteristics of populations living within and outside a 30-minute drive-time to HRSA-supported health centers to establish a baseline to better understand the differences in these populations. Using a descriptive, cross-sectional study design and geographic information systems, we found that 94% of persons in the US live within a 30-minute drive-time of a health center. Of those outside a 30-minute drive-time to a health center, 11.7 million (60.11%) are rural and over 1.5 million households (20.32%) lack broadband internet access. **Key words:** *access to care, broadband internet, geographic information systems, health centers, telehealth*

THE HEALTH RESOURCES and Services Administration (HRSA) Health Center Program (HCP) is well known for its role as a health care safety-net for America's most vulnerable populations. The HCP makes awards to (awardees) and affiliations with (look-alikes) community-based organizations that deliver whole person health care regardless of an individual's insurance status or ability to pay for care. While awardees and look-alikes (HCP-supported health centers, or health centers) provide many of the

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same services, look-alikes do not receive the same funding that awardees do. The HCP model is similar to the Penchansky et al. (1981) model of access requiring HCP-supported health centers to be available, accessible, affordable, provide accommodations, and be acceptable to patients. The health centers are "available," because they are located where the supply of health care providers may otherwise be limited. They are "accessible" because their placement is guided by travel time, distance, and cost. Health centers provide a sliding fee-scale and accept uninsured patients, making them "affordable." The "accommodations" provided vary by health center but include extended hours of operation, weekend hours, telehealth services, and transportation services. Because a community-based board, who are also health center patients, makes decisions about services and accommodations offered, and health centers often employ bilingual staff or otherwise provide translation services, the health centers offer services "acceptable" to the community.

HCP-supported health centers may operate one or several delivery sites and can be found in rural and urban areas. As of 2021, these 1481 HCP-supported health center organizations (1373 awardees and 108 look-alikes) served over 31 million people at over 15,000 service delivery sites (Bureau of Primary Health Care, 2021a, 2021b, n.d.). Accessibility is an important aspect of planning for new HCP-supported health center delivery sites in several ways. First, applicant organizations must define a service area. This geographic area should represent the community to be served and be rational, limiting time and distance to services. Second, they must prove that this service area is part of a Medically Underserved Area/ Population (MUA/P), a federal designation that covers a geographic area. This federal requirement attempts to ensure the neediest populations in the country are the ones served by the HCP. Third, health centers take advantage of federally designated Health Professional Shortage Areas (HPSA) to recruit providers to practice at the delivery sites. Once designated, HPSAs are scored and part of the score is based on a measure of accessibility defined by the distance to the nearest source of care.

For primary care HPSAs, scores range between 0 and 25 and this score includes a component based on travel time or distance to the nearest source of care from the population centroid of the designated area (Bureau of Health Workforce, n.d.). Up to five points are added to the score if the nearest source of care is excessively distant. To earn at least one point, in terms of travel time the nearest source of care must be at least 20 but no more than 30 minutes from the population centroid of the designated area. More points are added for travel times that exceed 30 minutes (Bureau of Health Workforce, 2020, 2018; S. Holloway, personal communication, September 8, 2023).

Outside of the HCP and federal shortage designations for primary care HPSAs, 30-minute drive-times are also used as measures of accessibility. Thirty-minute drive-times historically have been used by health planners to locate sites or quantify accessibility to services (Bosanac et al., 1976). Examples include the U.S. Department of Veterans Affairs and the U.S. Military Health System, which each use a 30-minute drive-time to establish eligibility for the Veterans Community Care Program (U.S. Department of Veterans Affairs, 2019) and some TRICARE programs (Military Health System, 2020), respectively. Recent research using the National Household Travel Survey defined medical/dental trips lasting equal to or greater than 30 minutes as a travel burden (Akinlotan et al., 2023). Living within a 30-minute drive-time to health care is associated with higher uptake of guideline-recommended screenings and cardiac rehabilitation (Military Health System, 2020). Additionally, living outside of a 30-minute drive-time to health care is associated with increased hospitalizations, higher costs, higher mortality rates, lower quality of life scores, and lower treatment plan adherence rates (Baldomero et al., 2022; Rocque et al., 2019).

Knowledge of population characteristics is critical to the Penchansky et al. (1981) model of access. Race and ethnicity have proven to be strongly correlated with health care access (Manuel, 2018), and health centers serve a disproportionate number of racial and ethnic minoritized patients, particularly Hispanic/Latino and Black/African American patients (Bureau of Primary Health Care, 2021a, 2021b; United States Census Bureau, 2020; Zuvekas et al., 2003). Poverty levels (both below 100% and below 199% of the Federal Poverty Level) and insurance status are proxies the HCP often use to assess whether they are reaching the nation's most economically vulnerable populations. Residents of rural areas are known to be served by fewer health professionals, have less access to primary care and preventive screening, and are disproportionately affected by an increasing number of hospital closings (Health Resources and Services Administration, 2020; Rural Health Information Hub, 2018). Vehicle access, defined as having 1 or more automobiles, vans, or trucks at home, is a key indicator of accessibility to health care services (Syed et al., 2013). Similar to having access to a vehicle, as telehealth becomes an increasingly viable and available modality for the provision of health care services and more health centers use it to better accommodate patients, it will be important to measure population-level broadband internet access to ensure that telehealth is a reasonable accommodation. Populations for which health centers are not accessible may similarly not be reachable by telehealth due to limited broadband availability.

Previous geographic studies have found that proximity to health centers is associated with increased utilization (ie, access to care), and that health centers have expanded to higher-need areas (Behr et al., 2022; Lee et al., 2023). While this success of the HCP is well documented, large numbers of low-income people remain unserved by health centers. This research seeks to evaluate the geographic reach of the HCP and quantify characteristics of the populations that have theoretical accessibility to health centers and those who do not. Using a standard measure of a 30-minute drive-time based on the literature, we seek to establish a baseline for who lives within and who lives outside this distance.

METHODS

Study design

We set out to determine the accessibility of the HCP using the Penchansky et al. (1981) definition. We obtained the locations of 13,432 health center awardee and look-alike service delivery sites across the U.S., the number of active sites as of June 2020 when the analysis was performed (Bureau of Primary Health Care, n.d.). We used Esri ArcMap 10.7.1's network analysis capabilities to create polygons around health centers that represent a 30-minute drive-time. Based on the road network and speed limits along road segments, this analysis simulates travel from a point, in this case a health center site, to see how far one could travel within 30 minutes. Once those limits were established, the travel path end points were connected to create the 30-minute drive-time polygon.

ArcMap was again used to determine whether census tracts were within a 30-minute drive-time of a health center. We chose census tracts as the geographic unit of analysis since both population and rurality data are reported at this level. Since the 30-minute drive-time polygons were not built using census tracts, we needed to establish a method for counting whether a census tract should be counted as "inside" the 30-minute drive-time polygons. Census tracts that were entirely within the 30-minute drive-time polygon were counted as "inside". If a census tract was partially within a 30-minute drive-time polygon, we classified the tract as "inside" if its population-weighted centroid fell within the polygon. Centroids reduce the shape of a census tract to a point within that shape. Population-weighted centroids place that point at

a location that represents the highest population density within that shape, thereby representing the population who live there based on where the people live since populations are not normally distributed across administrative geographic units. Because designated shortage areas do not align with census tract boundaries, we used a similar method to determine whether tracts were within or outside of a MUA/P or HPSA. While a Medically Underserved Population (MUP) designation covers a portion of the population within an area rather than all the population in that area, it still has a geographic component; therefore, MUPs were included in this analysis.

We used a standard 30-minute drive-time to build travel-time polygons around each delivery site based on road network and speed limit. We used a population centroid as opposed to other spatial analysis methods to categorize a tract as being within a 30-minute drive-time and within a HPSA or MUA/P. This method is supported by research on geographic spatial selection methods (Delamater et al., 2012; Hallisey et al., 2017). Figure 1 illustrates this methodology. Four census tracts are shown in an area that also includes a drive time polygon. Census tract 1 is completely within the polygon, so is considered "in." Census tract 4 is completely outside the polygon, so is "out." Census tracts 2 and 3 are partially in the polygon, so their population-weighted centroids are used for the analysis. Census tract 2 is "in" because the population-weighted centroid is in the polygon while census tract 3 is "out" because the centroid is outside the polygon.

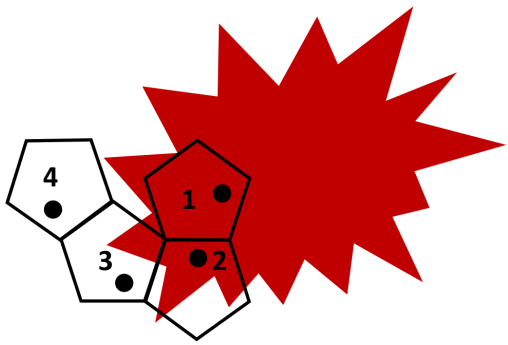

Figure 1. Census Tract Selection Example.

We joined the census tracts with population data and calculated descriptive statistics for populations inside and outside a 30-minute drive-time to ascertain population characteristics, such as race and ethnicity, vehicle access, broadband internet access, health insurance, poverty, living in a shortage area, and rurality.

Data sources

The study used 2010 census tracts from the U.S. Census Bureau; the updated 2020 census tracts were not used because the American Community Survey and rurality data had not yet been updated to these new geographies. We used the ArcGIS Streetmap Premium 2020 street network dataset to create the 30-minute drive-time polygons. We compiled population data from the 2015–2019 American Community Survey (ACS) and appended these summary data to census tracts, including data on population count (ACS table DP04), race and ethnicity (ACS table DP05), poverty status (ACS table S1701), vehicle access (ACS table DP04), health insurance status (ACS table S2701), and broadband internet access (ACS table B28011). We determined rurality status using 2019 revised Rural-Urban Commuting Area (RUCA) codes produced by the U.S. Department of Agriculture Economic Research Service. We used the HRSA Federal Office of Rural Health Policy (FORHP) definition of rural, with RUCA codes 4 to 10 designated as rural plus 123 tracts with RUCA codes 2 to 3 that FORHP designated as rural. This methodology assumes that the sparse population is uniformly distributed across the entire census tract (Health Resources and Services Administration, 2020). We used June 2020 health center location and shortage area designation data from the HRSA Data Warehouse. We used the most recent data available for all sources. Because the 2020 HRSA Data Warehouse data did not differ significantly from previous years (National

Association of Community Health Centers, 2022), we were able to combine them with the pre-pandemic data listed above.

Analytic approach

The geographic analysis created 30-minute drive time polygons for 13,432 health center locations. From this analysis, we created descriptive statistics of the populations that could theoretically be served at these locations. We chose to assess a 30-minute drive-time because it is the maximum time for travel to earn at least one point in the HPSA scoring methodology, and it is concordant with the health services accessibility literature. We chose census tracts to allow for as much geographic concordance as possible with the multiple datasets used in the analysis. Specifically, RUCA codes were not available for sub-census tract levels, nor were population centroids. Finally, we conducted t-tests to determine significant difference between these population characteristics.

RESULTS

Table 1 shows the proportion of the total U.S. population and subpopulations within and outside a 30-minute drive-time to a HRSA-supported health center. Subpopulations include those who live in shortage areas, people of different income levels, race/ethnicity, and others. Strikingly, 94% of persons in the US live in a census tract categorized as being within a 30-minute drive-time of a health center service delivery site (Table 1). To help contextualize these numbers, Table 1 includes these figures as a proportion of each subpopulation (e.g., 94.58% of people in poverty live within a 30-minute drive time of a health center and 5.42% of people in poverty do not). As seen in Table 1, for all indicators except American Indian/Alaska Native and rural populations, between 93% and 98% of each subpopulation live within a 30-minute drive-time of a health center. This includes the population in poverty (94.58%), population in a Primary Care HPSA (93.44%) or MUA/P (94.08%), households without a vehicle (95.97%), and most race and ethnicity categories. The exceptions are American Indian/Alaska Natives (81.38% live within a 30-minute drive-time of a health center site) and persons living in a rural census tract (77.19% are within a 30-minute drive-time of a health center site).

Table 1 also considers the population within each category to see how it compares to the breakdown of the U.S. population. For example, of everyone living in the U.S., 42.64% live in a Primary Care HPSA while 42.34% of everyone who lives in a 30-minute drive-time of a health center also lives in a Primary Care HPSA. All these population characteristic percentages were significantly different from the overall U.S. population at the $P < .001$ level. The data also illustrate that the populations living outside a 30-minute drive-time to any health center service delivery site have higher incomes, are more likely to be white, and have higher rates of insurance coverage, yet are overwhelmingly more rural than both the U.S. population and the population within a 30-minute drive-time. Additionally, over 11.7 million (60.11%) are rural and over 1.5 million households (20.32%) lack broadband internet access and 427,000 (5.66%) households outside a 30-minute drive-time are without a vehicle.

DISCUSSION

Summary

This study shows that a vast majority of persons in the US live within a 30-minute drive-time of a HRSA-supported health center. This includes uninsured, Medicaid, and racial and ethnic minoritized populations, meaning that health centers are in close proximity to the low-income and racially diverse communities they target. This is consistent with the literature exploring geographic access to health centers (Behr et al., 2022; Lee et al., 2023). However, these populations may still face other barriers to care.

Table 1. Proportion of U.S. Population and Sub-populations Inside vs. Outside 30-minute Drive-time from Health Center

Population Characteristics[e]	A—Total pop With Characteristic (% of US Total)	B—Population Inside 30-min Drive-Time (%)		C—Population Outside 30-min Drive-Time (%)	
		N	% (Column A denominator)	N	% (Column A denominator)
U.S.	327,892,544	308,346,053	94.04	19,546,491	5.96
Shortage areas					
Primary Care HPSA	139,827,129 (42.64%)	130,656,712 (42.37%)	93.44	9,170,417 (46.92%)	6.56
Dental Health HPSA	122,120,929 (37.24%)	114,053,534 (36.99%)	93.39	8,067,395 (47.27%)	6.61
Mental Health HPSA	175,345,275 (53.48%)	163,394,046 (52.99%)	93.18	11,951,229 (61.14%)	6.82
MUA/P	113,895,796 (34.74%)	107,152,790 (34.75%)	94.08	6,743,006 (34.50%)	5.92
Income[a]					
In poverty	43,939,542 (13.40%)	41,558,744 (13.48%)	94.58	2,380,798 (12.18%)	5.42
Low income	100,086,541 (30.52%)	94,280,602 (30.58%)	94.20	5,805,939 (29.70%)	5.80
Insurance status					
Uninsured	28,242,256 (8.61%)	26,634,829 (8.64%)	94.31	1,607,427 (8.22%)	5.69
Medicaid	66,252,355 (20.21%)	62,708,387 (20.34%)	94.65	3,543,968 (18.13%)	5.35
Medicare	56,059,596 (17.10%)	52,072,979 (16.89%)	92.89	3,986,617 (20.40%)	7.11
Private/other	218,390,816 (66.60%)	205,159,087 (66.54%)	93.94	13,231,729 (67.69%)	6.06
Race and ethnicity[b]					
White	237,476,800 (72.43%)	220,763,098 (71.60%)	92.96	16,713,702 (85.51%)	7.04
Black/African-American	41,616,287 (12.69%)	40,656,243 (13.19%)	97.69	960,044 (4.91%)	2.31
Asian	17,928,969 (5.47%)	17,538,517 (5.69%)	97.82	390,452 (2.00%)	2.18
American Indian/ Alaska Native	2,734,763 (0.83%)	2,225,470 (0.72%)	81.38	509,293 (2.61%)	18.62
Native Hawaiian/ Other Pacific Islander	600,014 (0.18%)	576,908 (0.19%)	96.15	23,106 (0.12%)	3.85
Multiple races[c]	10,935,802 (3.34%)	10,436,828 (3.38%)	95.44	498,974 (2.55%)	4.56
Hispanic/Latino	61,741,258 (18.83%)	59,726,157 (19.37%)	96.74	2,015,101 (10.31%)	3.26

(*continues*)

Table 1. Proportion of U.S. Population and Sub-populations Inside vs. Outside 30-minute Drive-time from Health Center (*Continued*)

Population Characteristics[e]	A—Total pop With Characteristic (% of US Total)	B—Population Inside 30-min Drive-Time (%)		C—Population Outside 30-min Drive-Time (%)	
		N	% (Column A denominator)	N	% (Column A denominator)
Physical access					
Rurality	51,502,353 (15.71%)	39,753,716 (12.89%)	77.19	11,748,637 (60.11%)	22.81
Without a vehicle[d]	10,583,011 (8.68%)	10,156,175 (8.88%)	95.97	426,836 (5.66%)	4.03
Without internet access[d]	20,947,912 (17.18%)	19,415,726 (16.98%)	92.69	1,532,186 (20.32%)	7.31

[a]Poverty is defined as below 100% of federal poverty guidelines. Low income is defined as 200% below federal poverty guidelines.
[b]Race and ethnicity categories are not mutually exclusive. Additionally, numbers for "other" race category have not been included, and therefore percentages will not add to 100%.
[c]Includes Hispanic/Latino and non-Hispanic/Latino.
[d]Households.
[e]We conducted t-tests to compare the differences between the populations within and outside of the 30-minute drive-time for each of the characteristics.

Implications

The fact that only 6% of persons in the US live outside a 30-minute drive-time of a health center illustrates the ubiquity of the HCP. However, the need for health care is still great, both inside and outside of these drive times. While the majority of those living outside of a 30-minute drive to a health center have access to a vehicle, research shows that living outside a 30-minute drive-time to a health care provider makes travel to and from the provider particularly challenging and affects accessibility to nearly every form of health care (Syed et al., 2013). There are several opportunities for HRSA-supported health centers to reach this patient population, as well as populations who have access issues not related to proximity or affordability (Xue et al., 2018).

Since an overwhelming majority of persons in the US, both living within or outside a 30-minute drive-time, have broadband internet access, telehealth could increase access to a range of health care service lines. As states ratified telehealth reimbursement and policies between 2018 and 2020, telehealth provision at health centers increased from 43% to 99% (Demeke et al., 2021; Health Resources and Services Administration, 2020). Research shows that telehealth, when offered to health center patients, leads to better health care access, satisfaction, and increases in preventive services while lowering costs (National Association of Community Health Centers, 2018; NORC at the University of Chicago, 2013). However, telehealth is not without its challenges. While telehealth funding has increased during the COVID-19 pandemic (Demeke et al., 2021), documented barriers still include low reimbursement rates, inadequate infrastructure funding, and lack of training (Kim et al., 2020; Lin et al., 2018). Additionally, many Americans, including the 21 million households mentioned in this study, lack the broadband internet access needed for video-based telehealth services (Bauerly et al., 2019). Audio-only options and related

policy changes could support telehealth efforts in areas where internet bandwidth or technology may not be readily available (National Association of Community Health Centers, 2021; Weigel et al., 2020).

Research has found that the provision of new health center service delivery sites is associated with improving health care access to medically underserved communities (Xue et al., 2018). Health centers' ability to add sites is largely dependent upon the funding they receive; studies have demonstrated that additional federal funding to community health centers has led to an increase in the number of sites and health services provided, specifically for low-income individuals (Lo Sasso and Byck, 2010; McMorrow and Zuckerman, 2013).

Furthermore, health center enabling services can further ensure accessibility to care for socio-demographically disadvantaged populations (Yue et al., 2019). Services for transportation can help increase access to high-quality health care services for patients of lower socioeconomic means, regardless of where patients reside in relation to service delivery sites (Schiaffino et al., 2020; Yue et al., 2019).

Limitations

We chose to use 30 minutes as the accessibility measure based on the existing literature. Drive-times are used rather than distances in these analyses because time, not distance, is the burden. Drive-times cover different distances in different areas due to road quality and speed limits. Driving distance within a 30-minute time span may also vary, given traffic conditions and time of day. These are common limitations of geographic access that are well documented (Apparicio et al., 2017). This analysis did not account for any variations in distance, because the goal was to establish a baseline. Future research will analyze different times and scenarios to see how populations served may be affected by these measures.

This analysis is based on the assumption that those within a 30-minute drive-time of a health center have access to an automobile, and we acknowledge that is not always the case, particularly in urban areas. Additionally, living within a 30-minute drive-time of a health center site does not guarantee that the drivable site offers the service(s) needed by a particular patient. Furthermore, not everyone without a vehicle, whether within or outside a 30-minute drive-time, has difficulty accessing care. Though a 30-minute drive-time is a documented criteria for scoring HPSAs, we acknowledge that geographic HPSAs and facility HPSAs, or what are known as auto-HPSAs used to allocate health center workforce resources, use additional designation criteria. Additionally, it is important to note that we examined population-level data, not individual-level data, and the experience of each health care consumer may vary.

The data on households without broadband internet refer to households with no internet subscription; that is, they do not pay for a cellular data plan, broadband access such as cable, fiber optic or DSL, or other type of internet service. Some households may not have an internet subscription but may be able to access internet outside the home, while some may not be able to afford internet or may have no option to purchase internet access.

For this analysis, we only examined HCP-supported health centers. It is possible that some patients, especially those living in rural areas, are served by another provider such as a Rural Health Clinic or Veterans Health Administration site. Additionally, some American Indians and Alaska Natives are served by safety net providers under the Indian Health Service or tribal government-run facilities.

Finally, we acknowledge that this research primarily concerns accessibility (measured using drive-time) and affordability, two of the five dimensions in the commonly cited Penchansky and Thomas model of health care access (Penchansky et al., 1981). While the Health Center Program works to address all barriers to

care, barriers in the dimensions of accommodation (e.g., lack of child care, no time off), availability (e.g., appointment times not convenient), and acceptability (e.g., negative perception of care providers) can affect individuals ability to access care, even if that care is within a 30-minute drive-time (Kullgren et al., 2012).

CONCLUSIONS

This research serves to establish a baseline of U.S. population that are within and outside of a 30-minute drive-time to a HCP health center delivery site. This measurement could not be found in the extant literature. Using a standard measure when access to care becomes excessively distant, we were able to determine that 94% of the U.S. population lives within a 30-minute drive-time to a HCP health center delivery site. The population breakdowns are significantly different for populations within and outside a 30-minute drive-time from the U.S. population as a whole, with the population outside a 30-minute drive-time being more likely to be white, have insurance, and live in rural areas.

REFERENCES

Akinlotan, M., Khodakarami, N., Primm, K., Bolin, J., Ferdinand, A. O. (2023). Travel for medical or dental care by race/ethnicity and rurality in the U.S.: findings from the 2001, 2009 and 2017 National Household Travel Surveys. *Preventive Medicine Reports*, *35*, 102297. doi:10.1016/j.pmedr.2023.102297

Apparicio, P., Gelb, J., Dube, A. S., Kingham, S., Gauvin, L., Robitaille, E. (2017). The approaches to measuring the potential spatial access to urban health services revisited: distance types and aggregation-error issues. *International Journal of Health Geographics*, *16*(2), 32. doi:10.1186/s12942-017-0105-9

Baldomero, A. K., Kunisaki, K. M., Wendt, C. H., Bangerter, A., Diem, S. J., Ensrud, K. E. ... Dudley, R. A. (2022). Drive time and receipt of guideline-recommended screening, diagnosis, and treatment. *JAMA Network Open*, *5*(11), e2240290. doi:10.1001/jamanetworkopen.2022.40290

Bauerly, B. C., McCord, R. F., Hulkower, R., Pepin, D. (2019). Broadband access as a public health issue: The role of law in expanding broadband access and connecting underserved communities for better health outcomes. *Journal of Law Medicine Ethics*, *47*(Supplement 2), 39–42. doi:10.1177/1073110519857314

Behr, C. L., Hull, P., Hsu, J., Newhouse, J. P., Fung, V. (2022). Geographic access to federally qualified health centers before and after the affordable care act. *BMC Health Services Research*, *22*(1), 385. doi:10.1186/s12913-022-07685-0

Bosanac, E. M., Parkinson, R. C., Hall, D. S. (1976). Geographic access to hospital care: A 30-minute travel time standard. *Medical Care*, *14*(7), 616–624. doi:10.1097/00005650-197607000-00006

Bureau of Health Workforce. (2018). *National Shortage Designation Modernization Project: Auto-HPSAs*. U.S. Department of Health and Human Services, Health Resources and Services Administration. Retrieved June 9, 2023, from https://bhw.hrsa.gov/sites/default/files/bhw/shortagedesignation/auto-hpsas-ta-webinar-may23-slides.pdf

Bureau of Health Workforce. (2020). *What is a Shortage Designation?* U.S. Department of Health and Human Services, Health Resources and Services Administration. Retrieved June 9, 2023, from https://bhw.hrsa.gov/workforce-shortage-areas/shortage-designation

Bureau of Health Workforce. (n.d.). *Scoring Shortage Designations*. U.S. Department of Health and Human Services, Health Resources and Services Administration. Retrieved June 9, 2023, from https://bhw.hrsa.gov/workforce-shortage-areas/shortage-designation/scoring

Bureau of Primary Health Care. (2021a). *HRSA Health Center Program: 2021 National Health Center Data*. U.S. Department of Health and Human Services, Health Resources and Services Administration. Retrieved June 9, 2023, from https://bphc.hrsa.gov/uds/datacenter.aspx

Bureau of Primary Health Care. (2021b). *HRSA Health Center Program: 2021 National Health Center Program Look-Alike Data*. U.S. Department of Health and Human Services, Health Resources and Services Administration. Retrieved June 9, 2023, from https://bphc.hrsa.gov/uds/lookalikes.aspx?state=national

Bureau of Primary Health Care. (n.d.). *Explore Data and Maps on HRSA's Health Care Programs*. U.S. Department of Health and Human Services, Health Resources and Services Administration. Retrieved June 9, 2023, from https://data.hrsa.gov

Delamater, P., Messina, J. P., Shortridge, A. M., Grady, S. C. (2012). Measuring geographic access to health care: raster and network-based methods.

International Journal of Health Geography, *11*(1), 15. doi:10.1186/1476-072X-11-15

Demeke, H., Merali, S., Marks, S., Pao, L. Z., Romero, L., Sandhu, P.,. . . Siza, C. (2021). Trends in use of telehealth among health centers during the COVID-19 pandemic—United States. *Morbidity and Mortality Weekly Report*, *70*(7), 240–244. doi:10.15585/mmwr.mm7007a3

Hallisey, E., Tai, E., Berens, A., Wilt, G., Peipins, L., Lewis, B. . . . B, N. (2017). Transforming geographic scale: a comparison of combined population and areal weighting to other interpolation methods. *International Journal of Health Geography*, *16*(1), 29. doi:10.1186/s12942-017-0102-z

Health Resources and Services Administration. (2020). *Defining Rural Population*. Author. https://www.hrsa.gov/rural-health/about-us/definition/index.html

Kim, J., Desai, E., Cole, M. (2020). How the Rapid Shift to Telehealth Leaves Many Community Health Centers Behind During the COVID-19 Pandemic. *Health Affairs Blog*. Retrieved June 9, 2023, from https://www.healthaffairs.org/do/10.1377/hblog20200529.449762/full/

Kullgren, J. T., McLaughlin, C. G., Mitra, N., Armstrong, K. (2012). Nonfinancial barriers and access to care for U.S. adults. *Health Services Research*, *47*(1 Pt 2), 462–485. doi:10.1111/j.1475-6773.2011.01308.x

Lee, E. K., Donley, G., Ciesielski, T. H., Freedman, D. A., Cole, M. B. (2023). Spatial availability of federally qualified health centers and disparities in health services utilization in medically underserved areas. *Social Science Medicine*, *328*, 116009. doi:10.1016/j.socscimed.2023.116009

Lin, C. C., Dievler, A., Robbins, C., Sripipatana, A., Quinn, M., Nair, S. (2018). Telehealth in health centers: key adoption factors, barriers, and opportunities. *Health Affairs*, *37*(12), 1967–1974. doi:10.1377/hlthaff.2018.05125

Lo Sasso, A. T., & Byck, G. R. (2010). Funding growth drives community health center services. *Health Affairs*, *29*(2), 289–296. doi:10.1377/hlthaff.2008.0265

Manuel, J. I. (2018). Racial/ethnic and gender disparities in health care use and access. *Health Services Research*, *53*(3), 1407–1429. doi:10.1111/1475-6773.12705

McMorrow, S., & Zuckerman, S. (2013). Expanding federal funding to community health centers slows decline in access for low-income adults. *Health Services Research*, *49*(3), 992–1010. doi:10.1111/1475-6773.12141

Military Health System. (2020). *TRICARE Prime Distance and Drive Time Standards*. U.S. Department of Defense. https://www.tricare.mil/primeaccess

National Association of Community Health Centers. (2018). *Expanding Access to Care: Streamlining Health Care Delivery Through Technology*. Retrieved June 9, 2023, from https://www.nachc.org/wp-content/uploads/2018/06/NACHC-2018-Policy-Paper-Telehealth.pdf

National Association of Community Health Centers. (2021). *Telehealth and Health Centers During COVID-19*. Retrieved June 9, 2023, from https://www.nachc.org/research-and-data/research-fact-sheets-and-infographics/health-centers-and-audio-only-telehealth-during-covid-19/

National Association of Community Health Centers. (2022). *Community Health Center Chartbook*. Retrieved June 9, 2023, from https://www.nachc.org/wp-content/uploads/2022/03/Chartbook-Final-2022-Version-2.pdf

NORC at the University of Chicago. (2013). *Understanding the Impact of Health IT in Underserved Communities and Those With Health Disparities*. University of Chicago. Retrieved June 9, 2023, from https://www.healthit.gov/sites/default/files/hit_disparities_report_050713.pdf

Penchansky, R., & Thomas, J. W. (1981). The concept of access: Definition and relationship to consumer satisfaction. *Medical Care.*, *19*(2), 127–140. doi:10.1097/00005650-198102000-00001

Rocque, G. B., Williams, C. P., Miller, H. D., Azuero, A., Wheeler, S. B., Pisu, M. . . . Kenzik, K. M. (2019). Impact of travel time on health care costs and resources use by phase of care for older patients with cancer. *Journal of Clinical Oncology*, *37*(22), 1935–1945. doi:10.1200/JCO.19.00175

Rural Health Information Hub. (2018). *Healthcare Access in Rural Communities*. https://www.ruralhealthinfo.org/topics/healthcare-access

Schiaffino, M. K., Suzuki, Y., Ho, T., Finlayson, T. L., Harman, J. S. (2020). Associations between nonclinical services and patient-experience outcomes in U.S. acute care hospitals. *Journal of Patient Experience*, *7*(6), 1086–1093. doi:10.1177/2374373519892770

Syed, S. T., Gerber, B. S., Sharp, L. K. (2013). Traveling towards disease: transportation barriers to health care access. *Journal of Community Health*, *38*(5), 976–993. doi:10.1007/s10900-013-9681-1

US Census Bureau . 2020 *QuickFacts: United States*. U.S. Department of the Treasury, U.S. Census Bureau. Retrieved June 9, 2023, from https://www.census.gov/quickfacts/fact/table/US/PST045222

U.S. Department of Veterans Affairs. 2019. *Veterans Community Care Program*. 38 CFR Sect. 17

Weigel, G., Ramaswamy, A., Sobel, L., Salganicoff, A., Cubanski, J., Freed, M. (2020). *Opportunities and Barriers for Telemedicine in the U.S. During the COVID-19 Emergency and Beyond*. Kaiser Family Foundation. https://www.kff.org/womens-health-policy/issue-brief/opportunities-and-barriers-for-telemedicine-in-the-u-s-during-the-covid-19-emergency-and-beyond/

Xue, Y., Greener, E., Kannan, V., Smith, J. A., Brewer, C., Spetz, J. (2018). Federally qualified

health centers reduce the primary care provider gap in health professional shortage counties. *Nursing Outlook*, *66*(3), 263–272. doi:10.1016/j.outlook.2018.02.003

Yue, D., Pourat, N., Chen, X., Lu, C. Z., Daniel, W., Hoang, M. . . . A, N. (2019). Enabling services improve access to care, preventive services, and satisfaction among health center patients. *Health Affairs*, *38*(9), 1468–1474. doi:10.1377/hlthaff.2018.05228

Zuvekas, S. H., & Taliaferro, G. S. (2003). Pathways to access: Health insurance, the health care delivery system, and racial/ethnic disparities, 1996–1999. *Health Affairs*, *22*(2), 139–153. doi:10.1377/hlthaff.22.2.139